



We claim:

1 1. A photonic crystal waveguide for coupling with optic devices comprising:  
2 a planar photonic crystal slab in which an array of holes is defined; and  
3 a waveguide defined by a line defect defined in said slab, said line defect  
4 being created by a geometric perturbation of at least a first set of holes with  
5 respect to a second set of holes to create at least one guided mode of light  
6 propagation in said waveguide which exhibits reduced vertical and lateral losses,  
7 increased coupling of light into said slab, and closer matching of frequencies of  
8 eigen modes of said optic devices coupled to said waveguide.

1 2. The waveguide of claim 1 where said geometric perturbation is a  
2 positional displacement of said first set of holes with respect to said second set of  
3 holes in a predetermined direction, said first and second set of holes having the  
4 same diameter of hole therein.

1 3. The waveguide of claim 1 where said predetermined direction is the  $\Gamma X$   
2 direction in said slab, said waveguide being defined as a type 1 waveguide.

1 4. The waveguide of claim 1 where said predetermined direction is the  $\Gamma J$   
2 direction in said slab, said waveguide being defined as a type 2 waveguide.

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1 5. The waveguide of claim 4 where said positional displacement,  $d$ , is a  
2 fraction,  $l$ , of lattice spacing,  $a$ , of said array,  $d = l \cdot a$ , where  $0 < l < 1$ .

1 6. The waveguide of claim 5 where  $d = 0.5a$ .

1 7. The waveguide of claim 5 where said waveguide has a bandgap and  
2 where  $d$  is reduced until both acceptor-type modes and donor-type modes are  
3 positioned in the bandgap of said waveguide.

1 8. The waveguide of claim 1 where said slab has a bandgap, an air band and  
2 a dielectric band for propagation of modes and where said geometric  
3 perturbation is created by displacement of holes into a positions within said array  
4 of holes where dielectric is normally present to pull modes from the dielectric  
5 band into the bandgap.

1 9. The waveguide of claim 1 where said slab has a bandgap, an air band and  
2 a dielectric band for propagation of modes and where said geometric  
3 perturbation is created by displacement of dielectric into a positions within said  
4 array of holes where air is normally present to pull modes from the air band into  
5 the bandgap.

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1 10. The waveguide of claim 1 where said geometric perturbation is created by  
2 increasing or decreasing the diameter of a first set of holes in said array of holes  
3 relative to a second set of holes comprising a remainder of holes of said array,  
4 said first set of holes being adjacent at least in part to said line defect, said  
5 waveguide defined as a type-3 waveguide.

1 11. The waveguide of claim 10 where slab has a bandgap and an air band  
2 and where second set of holes has a radius,  $r = 0.3a$  and said first set of holes  
3 has a radius,  $r_{\text{defect}} = 0.2a$  and said array of holes has a triangular lattice so that  
4 only air band modes are pulled down in the bandgap and no acceptor-type  
5 modes are present.

1 12. The waveguide of claim 10 where slab has a bandgap and an air band  
2 and where second set of holes has a radius,  $r = 0.3a$  and said first set of holes  
3 has a radius,  $r_{\text{defect}} = 0.45a$  and said array of holes has a triangular lattice so that  
4 only acceptor-type modes are present.

1 13. The waveguide of claim 1 where said light is guided in said waveguide  
2 due to photonic bandgap (PBG) effect.

1 14. A method for defining a photonic crystal waveguide for coupling with optic  
2 devices comprising:



3 defining an array of holes in a planar photonic crystal slab; and  
4 creating a line defect in said slab to define said waveguide, said line  
5 defect being created by a geometric perturbation of at least a first set of holes  
6 with respect to a second set of holes to create at least one guided mode of light  
7 propagation in said waveguide which exhibits reduced vertical and lateral losses,  
8 increased coupling of light into said slab, and closer matching of frequencies of  
9 eigen modes of said optic devices coupled to said waveguide.

1 15. The method of claim 14 where creating said line defect comprises forming  
2 said first set of holes displaced in a predetermined direction with respect to said  
3 second set of holes, said first and second set of holes having the same diameter  
4 of hole therein.

1 16. The method of claim 14 where forming said first set of holes displaces  
2 said holes in the  $\Gamma X$  direction in said slab, said waveguide being defined as a  
3 type 1 waveguide.

1 17. The method of claim 14 where forming said first set of holes displaces  
2 said holes in the  $\Gamma J$  direction in said slab, said waveguide being defined as a type  
3 2 waveguide.



1 18. The waveguide of claim 17 where forming said first set of holes displaces  
2 said holes by a displacement,  $d$ , is a fraction,  $l$ , of lattice spacing,  $a$ , of said array,  
3  $d = l \cdot a$ , where  $0 < l < 1$ .

1 19. The method of claim 18 where forming said first set of holes displaces  
2 said holes by a displacement,  $d = 0.5$ .

1 20. The method of claim 18 where said waveguide has a bandgap and where  
2 forming said first set of holes displaces said holes by a  $d$  which is reduced until  
3 both acceptor-type modes and donor-type modes are positioned in the bandgap  
4 of said waveguide.

1 21. The method of claim 14 where said slab has a bandgap, an air band and a  
2 dielectric band for propagation of modes and where creating said line defect  
3 comprises forming said first set of holes displaced by displacement of holes into  
4 positions within said array of holes where dielectric is normally present to pull  
5 modes from the dielectric band into the bandgap.

1 22. The method of claim 14 where said slab has a bandgap, an air band and a  
2 dielectric band for propagation of modes and where creating said line defect  
3 comprises forming said first set of holes displaced by displacement of holes into

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4 positions within said array of holes where air is normally present to pull modes  
5 from the air band into the bandgap.

1 23. The method of claim 1 where creating said line defect comprises  
2 increasing or decreasing the diameter of a first set of holes in said array of holes  
3 relative to a second set of holes comprising a remainder of holes of said array,  
4 said first set of holes being adjacent at least in part to said line defect, said  
5 waveguide defined as a type-3 waveguide.

1 24. The method of claim 23 where slab has a bandgap and an air band and  
2 where creating said line defect comprises decreasing the diameter of a first set of  
3 holes to a radius,  $r_{\text{defect}} = 0.2a$  and said second set of holes has a radius,  $r = 0.3a$   
4 and said first set of holes has said array of holes has a triangular lattice so that  
5 only air band modes are pulled down in the bandgap and no acceptor-type  
6 modes are present.

1 25. The method of claim 23 where slab has a bandgap and an air band and  
2 where creating said line defect comprises increasing the diameter of a first set of  
3 holes to a radius  $r_{\text{defect}} = 0.45a$ , where second set of holes has a radius,  $r = 0.3a$ ,  
4 and said array of holes has a triangular lattice so that only acceptor-type modes  
5 are present.

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- 1 26. The method of claim 1 where creating said line defect comprises guiding
- 2 light in said waveguide solely due to photonic bandgap (PBG) effect.

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